

CLAIMS

What is claimed is:

- 1 1. An optical apparatus for transmitting an optical signal,
2 comprising:
3 a static filter that has wavelength dependent transmission;
4 a Faraday rotator;
5 a reflector; and
6 wherein the Faraday rotator makes a first change in polarization of
7 the optical signal in a first direction and a second change in polarization of
8 the optical signal received from the reflector in a second direction to
9 produce a polarization of the optical signal that is substantially orthogonal
10 to an initial polarization state of the optical signal.
- 1 2. The apparatus of claim 1, wherein the Faraday rotator has a
2 nominally 45° rotation for linear polarization.
- 1 3. The apparatus of claim 1, further comprising:
2 a lens positioned to image the optical signal to an optical fiber.
- 1 4. The apparatus of claim 3, wherein the lens is positioned
2 between the optical fiber and the static filter.
- 1 5. The apparatus of claim 3, wherein the lens is positioned
2 between the static filter and the Faraday rotator.
- 1 6. The apparatus of claim 3, wherein the lens is positioned
2 between the Faraday rotator and the reflector.
- 1 7. The apparatus of claim 1, wherein the reflector is a high
2 reflector.

1 8. The apparatus of claim, wherein the reflector reflects at least
2 50% of incident light.

1 9. The apparatus of claim 1, wherein the static filter includes
2 dielectric films and a transparent substrate.

1 10. The apparatus of claim 1, wherein the static filter is an
2 interference filter.

1 11. The apparatus of claim 1, wherein the static filter is a fiber
2 based filter.

1 12. The apparatus of claim 1, wherein the static filter is a
2 waveguide filter.

1 13. The apparatus of claim 1, further comprising:
2 a mode coupler coupled to an optical fiber and configured to create
3 perturbations in the optical modes in the optical fiber and provide coherent
4 coupling between two modes in the optical fiber.

1 14. The apparatus of claim 13, wherein the optical fiber has a
2 cladding surrounding a core.

1 15. The apparatus of claim 13, wherein the mode coupler is
2 selected from an acoustic grating, a UV grating, a bending grating and a
3 stress induced grating.

1 16. The apparatus of claim 13, wherein the mode coupler
2 includes an acoustic wave generator and an acoustic wave propagation
3 member coupled to the optical fiber.

1 17. The apparatus of claim 13, wherein the mode coupler couples
2 a first core mode to a second core mode.

1 18. The apparatus of claim 13 wherein the mode coupler couples
2 a core mode to a cladding mode.

1 19. The apparatus of claim 13 wherein the mode coupler couples
2 a cladding mode to a core mode.

1 20. -The apparatus of claim 13 wherein the mode coupler couples
2 a cladding mode to a different cladding mode.

1 21. The apparatus of claim 13 wherein the mode coupler includes
2 an acoustic wave generator that produces multiple acoustic signals with
3 individual controllable strengths and frequencies, each of the acoustic
4 signals providing a coupling between different modes traveling within the
5 optical fiber.

1 22. The apparatus of claim 13, wherein the mode coupler
2 includes a temperature controlled grating that is temperature tunable.

1 23. The apparatus of claim 13, wherein the mode coupler
2 includes a stress induced grating that is stress tunable.

1 24. The apparatus of claim 13, wherein the mode coupler
2 includes an acoustic wave generator that produces longitudinal waves.

1 25. The apparatus of claim 13, wherein the mode coupler
2 includes an acoustic wave generator that produces torsional waves.

1 26. The apparatus of claim 13, wherein the mode coupler
2 includes an acoustic wave generator that produces transverse waves.

1 27. The apparatus of claim 13, wherein the mode coupler
2 includes an acoustic wave generator and a wavelength of an optical signal
3 coupled between two different modes traveling within the optical fiber is

4 changed by varying the frequency of a signal applied to the acoustic wave
5 generator.

1 28. The apparatus of claim 13, wherein the mode coupler
2 includes an acoustic wave generator and an amount of an optical signal
3 coupled between two different modes traveling within the optical fiber is
4 changed by varying the amplitude of a signal applied to the acoustic wave
5 generator.

1 29. An optical apparatus for transmitting an optical signal,
2 comprising:

3 a static filter that has wavelength dependent transmission;

4 a Faraday rotator;

5 a variable optical attenuator that attenuates at least a portion of the
6 optical signal;

7 a reflector; and

8 wherein the Faraday rotator makes a first change in polarization of
9 the optical signal in a first direction, and a second change in polarization of
10 the optical signal received from the reflector in a second direction to
11 produce a polarization of the optical signal that is substantially orthogonal
12 to an initial polarization state of the optical signal.

1 30. The apparatus of claim 29, wherein the Faraday rotator has a
2 nominally 45° rotation for linear polarization.

1 31. The apparatus of claim 29, further comprising:
2 a lens positioned to image the optical signal to an optical fiber.

1 32. The apparatus of claim 29, wherein the variable optical
2 attenuator is positioned between the static filter and the Faraday rotator.

1 33. The apparatus of claim 29, wherein the variable optical
2 attenuator is positioned between the Faraday rotator and the reflector.

1 34. The apparatus of claim 31, wherein the variable optical
2 attenuator is positioned between the lens and the static filter.

1 35. The apparatus of claim 31, wherein the lens is positioned
2 between the optical fiber and the static filter.

1 36. The apparatus of claim 31, wherein the lens is positioned
2 between the static filter and the Faraday rotator.

1 37. The apparatus of claim 31, wherein the lens is positioned
2 between the Faraday rotator and the reflector.

1 38. The apparatus of claim 29, wherein the reflector is a high
2 reflector.

1 39. The apparatus of claim 29, wherein the reflector reflects at
2 least 50% of incident light.

1 40. The apparatus of claim 29, wherein the filter includes
2 dielectric films and a transparent substrate.

1 41. The apparatus of claim 29, wherein the filter is an
2 interference filter.

1 42. The apparatus of claim 29, wherein the filter is a fiber based
2 filter.

1 43. The apparatus of claim 29, wherein the filter is a waveguide
2 filter.

- 1 44. The apparatus of claim 29, further comprising:
2 a mode coupler coupled to an optical fiber and configured to create
3 perturbations in the optical modes in the optical fiber and provide coherent
4 coupling between a first mode to a second mode in the optical fiber.
- 1 45. The apparatus of claim 44, wherein the optical fiber has a
2 cladding surrounding a core.
- 1 46. The apparatus of claim 44, wherein the mode coupler is
2 selected from an acoustic grating, a UV grating, a bending grating and a
3 stress induced grating.
- 1 47. The apparatus of claim 44, wherein the mode coupler
2 includes an acoustic wave generator and an acoustic wave propagation
3 member coupled to the optical fiber.
- 1 48. The apparatus of claim 44, wherein the mode coupler couples
2 a first core mode to a second core mode.
- 3 49. The apparatus of claim 44 wherein the mode coupler couples
4 a core mode to a cladding mode.
- 1 50. The apparatus of claim 44 wherein the mode coupler couples
2 a cladding mode to a core mode.
- 1 51. The apparatus of claim 44 wherein the mode coupler couples
2 a cladding mode to a different cladding mode.
- 1 52. The apparatus of claim 44 wherein the mode coupler includes
2 an acoustic wave generator that produces multiple acoustic signals with
3 individual controllable strengths and frequencies, each of the acoustic

4 signals providing a coupling between different modes traveling within the
5 optical fiber.

1 53. The apparatus of claim 44, wherein the mode coupler
2 includes a temperature controlled grating that is temperature tunable.

1 54. The apparatus of claim 44, wherein the mode coupler
2 includes a stress induced grating that is stress tunable.

1 55. The apparatus of claim 44, wherein the mode coupler
2 includes an acoustic wave generator that produces longitudinal waves.

1 56. The apparatus of claim 44, wherein the mode coupler
2 includes an acoustic wave generator that produces torsional waves.

1 57. The apparatus of claim 44, wherein the mode coupler
2 includes an acoustic wave generator that produces transverse waves.

1 58. The apparatus of claim 44, wherein the mode coupler
2 includes an acoustic wave generator and a wavelength of an optical signal
3 coupled between two different modes traveling within the optical fiber is
4 changed by varying the frequency of a signal applied to the acoustic wave
5 generator.

1 59. The apparatus of claim 44, wherein the mode coupler
2 includes an acoustic wave generator and an amount of an optical signal
3 coupled between two different modes traveling within the optical fiber is
4 changed by varying the amplitude of a signal applied to the acoustic wave
5 generator.

1 60. An optical apparatus for transmitting an optical signal,
2 comprising:
3 a static filter that has wavelength dependent transmission;

4 a Faraday rotator;
5 a reflector positioned along a first optical path defined by the static
6 filter, the Faraday rotator and the reflector, the reflector reflecting at least a
7 portion of the optical signal back in a direction towards the Faraday rotator
8 along an optical path that is not the first optical path; and
9 wherein the Faraday rotator makes a first change in polarization of
10 the optical signal received from the static filter, and a second change in
11 polarization of the optical signal received from the reflector to produce a
12 polarization of the optical signal that is substantially orthogonal to an initial
13 polarization state of the optical signal.

1 61. The apparatus of claim 60, wherein the Faraday rotator has a
2 nominally 45° rotation for linear polarization.

1 62. The apparatus of claim 60, further comprising:
2 a lens positioned to image the optical signal to an optical fiber.

1 63. The apparatus of claim 62, wherein the lens is positioned
2 between the optical fiber and the static filter.

1 64. The apparatus of claim 62, wherein the lens is positioned
2 between the static filter and the Faraday rotator.

1 65. The apparatus of claim 62, wherein the lens is positioned
2 between the Faraday rotator and the reflector.

1 66. The apparatus of claim 60, wherein the reflector is a high
2 reflector.

1 67. The apparatus of claim 60, wherein the reflector reflects at
2 least 50% of incident light.

1 68. The apparatus of claim 60, wherein the static filter includes
2 dielectric films and a transparent substrate.

1 69. The apparatus of claim 60, wherein the static filter is an
2 interference filter.

1 70. The apparatus of claim 60, wherein the static filter is a fiber
2 based filter.

1 71. The apparatus of claim 60, wherein the static filter is a
2 waveguide filter.

1 72. The apparatus of claim 60, further comprising:
2 a mode coupler coupled to an optical fiber and configured to create
3 perturbations in the optical modes in the optical fiber and provide coherent
4 coupling between a first mode to a second mode in the optical fiber.

1 73. The apparatus of claim 72, wherein the optical fiber has a
2 cladding surrounding a core.

1 74. The apparatus of claim 72, wherein the mode coupler is
2 selected from an acoustic grating, a UV grating, a bending grating and a
3 stress induced grating.

1 75. The apparatus of claim 72, wherein the mode coupler
2 includes an acoustic wave generator and an acoustic wave propagation
3 member coupled to the optical fiber.

1 76. The apparatus of claim 72, wherein the mode coupler couples
2 a first core mode to a second core mode.

1 77. The apparatus of claim 72, wherein the mode coupler couples
2 a core mode to a cladding mode.

1 78. The apparatus of claim 72, wherein the mode coupler couples
2 a cladding mode to a core mode.

1 79. The apparatus of claim 72, wherein the mode coupler couples
2 a cladding mode to a different cladding mode.

1 80. The apparatus of claim 72, wherein the mode coupler
2 includes an acoustic wave generator that produces multiple acoustic signals
3 with individual controllable strengths and frequencies, each of the acoustic
4 signals providing a coupling between different modes traveling within the
5 optical fiber.

1 81. The apparatus of claim 72, wherein the mode coupler
2 includes a temperature controlled grating that is temperature tunable.

1 82. The apparatus of claim 72, wherein the mode coupler
2 includes a stress induced grating that is stress tunable.

1 83. The apparatus of claim 72, wherein the mode coupler
2 includes an acoustic wave generator that produces longitudinal waves.

1 84. The apparatus of claim 72, wherein the mode coupler
2 includes an acoustic wave generator that produces torsional waves.

1 85. The apparatus of claim 72, wherein the mode coupler
2 includes an acoustic wave generator that produces transverse waves.

1 86. The apparatus of claim 72, wherein the mode coupler
2 includes an acoustic wave generator and a wavelength of an optical signal
3 coupled between two different modes traveling within the optical fiber is
4 changed by varying the frequency of a signal applied to the acoustic wave
5 generator.

1 87. The apparatus of claim 72, wherein the mode coupler
2 includes an acoustic wave generator and an amount of an optical signal
3 coupled between two different modes traveling within the optical fiber is
4 changed by varying the amplitude of a signal applied to the acoustic wave
5 generator.

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